COMMONWEALTH OF PENNSYLVANIA.

DEPARTMENT OF AGRICULTURE.

BULLETIN NO. 43.

The San José Scale, and other Scale Insects.

By H. T. FERNALD, Ph. D.,
State Zoologist.

PUBLISHED BY DIRECTION OF THE SECRETARY.

WM. STANLEY RAY,
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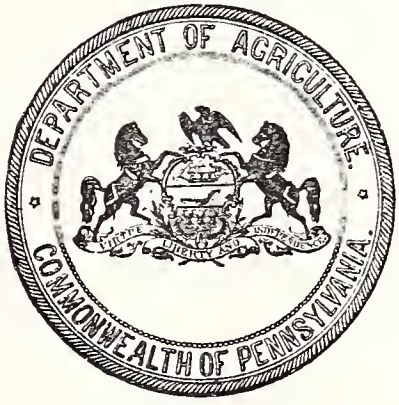

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COMMONWEALTH OF PENNSYLVANIA,
DEPARTMENT OF AGRICULTURE,
DIVISION OF ZOOLOGY,
HARRISBURG, PA., *March 7, 1899.*

HON. THOS. J. EDGE, *Secretary of Agriculture:*

Sir: I have the honor to offer for publication the following article on the San José Scale and other scale insects, as one of the Bulletins of the Department. The necessity for such a publication is demonstrated, both by the number of inquiries received by the Department, on subjects covered by this article, and by the large and annually increasing loss to fruit growers and nurserymen in this State from scale insects, and it is believed that the publication of the material contained herein will meet the increasing demand for information on this subject.

Respectfully submitted,

H. T. FERNALD,
Economic Zoologist.

THE SAN JOSÉ SCALE, AND OTHER SCALE INSECTS.

Ten years ago most fruit growers and nurserymen in Pennsylvania knew little and cared less about scale insects on their trees and plants, but since the appearance of the San José Scale in the State this condition has rapidly changed, the destruction of fruit trees by this pest having compelled them to turn their attention in this direction.

The loss caused by scale insects, and particularly by the San José (pronounced San Ho-zay) Scale is great, and is each year increasing as the insect becomes more abundant, and must soon reach millions of dollars unless something is done to prevent it. The insects themselves are so small (in some cases almost microscopic), that they are generally overlooked until they become so abundant as to seriously affect the health of the trees they are on, and even then it is often the case that the cause of the injury is unsuspected.

In order that fruit growers and nurserymen may be able to protect their trees from the ravages of these pests, they should be familiar with the appearance of the different kinds of scale insects, and should learn the best methods of treatment for their destruction, and with these objects in mind this bulletin has been prepared, to meet the requests for information on these points, which form quite a part of the correspondence of the Division of Zoology.

THE SAN JOSÉ SCALE.

(*Aspidiotus perniciosus* Comst.)

The home of this insect is unknown, though it now seems probable that it is a native of Japan. It appeared in this country about 1870, in California, in the San José Valley, and rapidly spread over that entire region. In 1893 it appeared at Charlottesville, Va., and inquiries showed that it was probably brought there from New Jersey. This led to an investigation of the nurseries of that State with interesting results. It seems that the plum is so badly attacked by the curculio, that two of the nurseries in New Jersey began about 1886 to search for "curculio-proof" varieties of plum, and in 1886 or 1887, both introduced the Japanese variety known as the "Kelsey" with this

object in view. A lot of this stock was obtained by the two nurseries referred to, from California, and thus, ignorantly, the San José Scale was brought to the Eastern United States. The trees did not do well (probably because they were infested with the scale) and after a time most of them were destroyed, but not until the scale had spread from them to the other nursery stock. This stock was sold in different

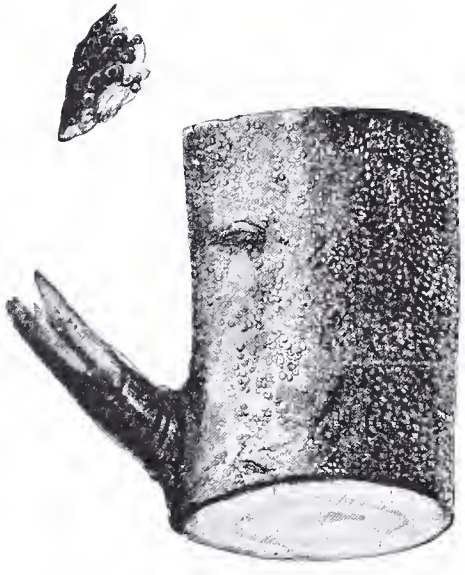

Fig. 1.—San José Scale, natural size, on apple; scales shown enlarged, on piece of bark, at left. above. (*Howard, Circ. 3, Second Series, Div. Ent., U. S. Dept. Agr.*)

places, and in this way the San José Scale was scattered all over the Eastern United States before the fact was known or realized. Each place where an infested plant was shipped to, became in its turn a center for dispersal, and the scale is now found in thirty-four States and territories and in Canada and British Columbia, besides Chili, Japan, Australia and other foreign countries.

DESTRUCTIVENESS.

That this scale is really a serious pest, causing great loss, is shown by the following quotations from fruit growers and others who have had experience with it:

"I have been a fruit grower all my life, and in all my experience I have never had to contend with such a persistent, deadly enemy as the San José Scale. It costs me annually more hard work and cash outlay than all the other insects of the orchard combined. I consider it the worst orchard pest ever established on American soil."—Robert S. Emory, Chestertown, Md.

"I cannot imagine a more deadly, destructive enemy to peach trees than this insect. The 28,000 fine, healthy peach trees in our orchard

two years ago, at present evidences the penalty we have paid to its introduction into this State."—George K. McGaw, Md.

"I know of nothing so destructive to fruit trees as the San José scale; besides, I am satisfied it will spread over a whole orchard in two seasons, if not checked."—L. A. Palmer, Md.

"I regard the San José Scale as the most dangerous insect of which I have any knowledge, and more to be dreaded than even the yellows by peach growers."—J. P. Blessing, Md.

"I very much fear this pernicious insect will ruin the fruit industry of the State."—Elymet Dows, Md.

"From what I have seen of it, I think it is the most pernicious insect known in this country; certainly I never saw another species so abundant as this is in certain orchards I have visited. It attacks the bark of the trunk and limbs as well as the leaves and fruit. I have seen many plum and apple trees upon which the fruit was so badly infested that it was unmarketable. In other instances, I have seen the bark of all the small limbs completely covered by the scales."—Prof. Comstock; Report U. S. Dept. Agr., 1880.

"There is perhaps no insect capable of causing greater damage to fruit interests in the United States, or perhaps the world, than the San José Scale. We are, therefore, justified in the assertion that no more serious menace to the deciduous fruit interests of the country has ever been known."—Dr. L. O. Howard, U. S. Entomologist.

LIFE HISTORY.

The insect passes the winter under the scale, and protected by it from the weather. At this time it may be in almost any stage of growth from the very young up to the full grown adult. It is probable however, that most of the younger individuals as well as the adults die during the winter, while the half or three-quarter grown ones remain alive. When spring comes on these mature, and begin to reproduce, bringing forth living young. The first of these appear about the first of June, the exact time varying with the temperature and latitude. These young are very different in appearance from the parents which produced them, being extremely small, orange-yellow in color, and having six short legs. These little fellows crawl out from under the parent scale and move about on the twig or wherever they may find themselves for but a day or two. They then settle down, become quiet, and gradually work their beaks into the bark and suck the juices from the tree. Before settling down, little white, waxy threads appear over the surface of the body and after the insect has become quiet these grow together and form the covering scale. When this process has been completed the scale is nearly circular, white in color, and with a little hump or nipple in the middle. About

ten days later the insect under the scale sheds its outer shell (molts) and adds this shell to the scale which has now become dark grey, except the central hump, which is lighter colored and may even be yellow at this time. The female scales molt again about ten days later and add this second molted shell to the scale thus making it larger than that of the male scales which do not have this second molt.

Soon after the second molt, the females begin to produce their young averaging over ten a day for about six weeks, each thus producing about 500 young on the average. Before the last of these 500

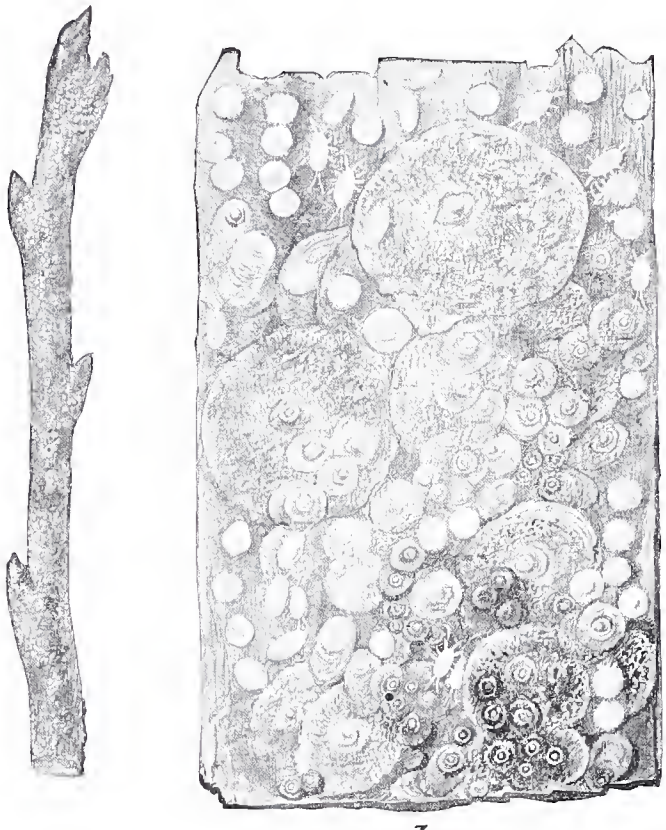

Fig. 2.—San José Scale; *a*, on twig, natural size; *b*, bark of same much enlarged, showing scales of different ages and also the crawling young. (*Howard and Marlatt, Bull. 3, N. S., Div. Ent. U. S. Dept. Agr.*)

have appeared, however, the first ones have become full grown and are also producing young, and as a result, young, crawling forms may be found at almost any time from the middle or last of June until frost sets in. It has been calculated that this length of time is sufficient for the descendants of a single female to reach the astonishing number of 1,608,040,200 individuals, all of which will do their share in abstracting the juices from the tree they are on. With an increase of numbers as rapid as this it is not to be wondered at that a tree apparently healthy in the spring may be almost dead by the time the next winter begins.

The female scales when full grown are almost circular and may measure 2 mm. in diameter, though usually they are not much more than half this size. The male scales are rather more oval and do not generally measure more than 1 mm. The female remains under the scale all her life after once settling down, but the male after feeding under its scale for about twenty days changes its appearance and finally escapes from beneath the scale as a very small insect with wings, which it uses to fly about with in search of the female with which it pairs.

FOOD PLANTS.

The San José Scale feeds on all our common fruit trees as well as on many other plants. It does not seem to attack evergreens, however. A few of its most important food plants are the peach, plum, cherry,

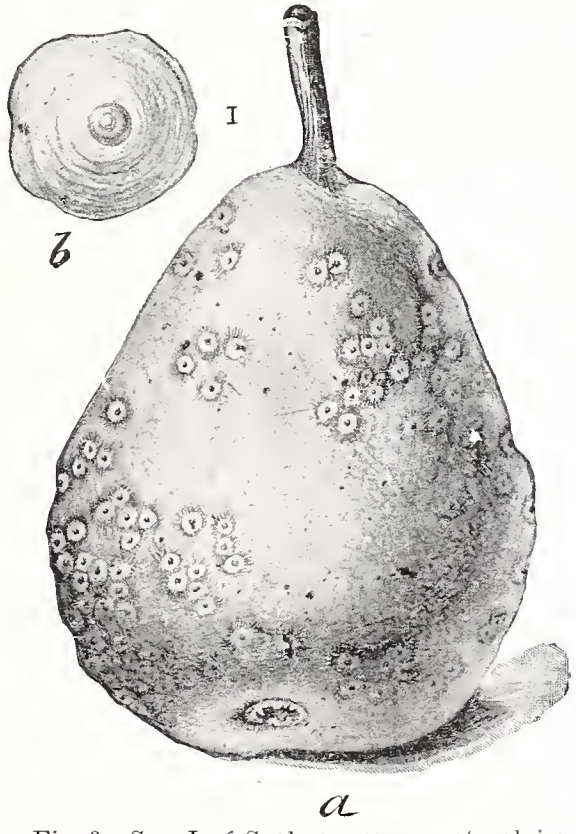

Fig. 3.—San José Scale on pear; *a*, natural size, *b*, female scale much enlarged—its real size shown by the line to the right. (*Howard, Circ. 3, Second Series, Div. Ent., U. S. Dept. Agr.*)

raspberry, blackberry, rose, pear, apple, quince, gooseberry, currant, grape, linden, elm, osage orange, English walnut, pecan, hickory, chestnut, oak, birch, alder and several kinds of willows. Peach trees suffer severely from its attacks and die in two or three years. Trunk, branches, twigs, and even leaves and fruit of the plant become infested in some cases.

HOW THE SCALE IS SPREAD.

There are several ways in which the scale is spread. This occurs during the time when the young are crawling around, and as has already been shown this is from early in July or even in June until frost appears, thus giving abundant time in which the distributing influences can work. Among these the wind is an important factor. The young as they crawl around, jar off easily and may, in this way, be readily blown from one tree to another, or to the ground near enough to a tree to enable them to reach it. Larger insects flying from one tree to another may become covered by the young crawling onto them while they rest on an infested tree, then flying to another tree may leave the young there. This has been actually seen to occur. Similarly, birds may carry the young from one place to another, and finally, where branches of adjoining trees touch, the young may crawl directly from one tree to another.

ENEMIES OF THE SCALE.

There are several insects which are parasites on the scale and do good work. Their reproductive powers, however, are not equal to those of the scale, which in consequence increases in numbers far more rapidly than do the parasites.

Certain lady-birds are also enemies of the scale, feeding freely on them; the most common one here being the "Twice-stabbed lady-bird," a little black rounded beetle, about an eighth of an inch long, having two orange or blood-red spots on its back. It would be of more aid in keeping the scale in check if this pest did not multiply so rapidly.

There is also a fungus which has been found attacking the scale in Florida and elsewhere, and which is being experimented with in the hope that it may be possible to induce it to flourish in more northern climates and destroy the scales there. While this idea is most commendable, the results thus far, however, have not been particularly encouraging.

TREATMENT.

How to treat the San José Scale has been a much discussed question. On the Pacific coast the usual method has been to apply to the infested trees, either a lime, sulphur and salt wash or a resin wash, various formulas for which have been published. These washes have in general proved to be successful, and "there is no doubt that orchards, once threatened with destruction, have been practically freed from the scale by using them, and in the Sacramento Valley region, where there are immense deciduous orchards, the lime, sulphur and salt is applied almost annually by nearly all growers."

When the scale first appeared in the east these remedies were at once carefully tested, and the surprising fact was discovered that though they may be effective in California they are of but little value here, being "fatal to only a small percentage of scales." Why such different results should be obtained, it is difficult to say. It is possible, however, that as in California the washes are applied to the trees some little time before the beginning of the rainy season, they have an opportunity to act for some time on the scales before being washed off by the rains. In the East, on the other hand, the wash must be applied at a season when rains are frequent, and it is possible that it is removed by them before it has remained on the trees long enough to accomplish the destruction of the scales.

Under such conditions, farther consideration of methods in use in California is needless and other remedies must be considered. As the San José scale is a sucking insect, no stomach poison, such as Paris green, would be of any value, and the substance used must be something which will kill it by contact. But as the insect is covered by the hard scale, this substance must be strong enough to eat or corrode the scale, thus making its way through it to the body of the insect lying beneath.

Several methods of treatment for the scale have been tried with varying degrees of success, and are here taken up in some detail.

DESTRUCTION OF INFESTED TREES.

In cases where the scale has just appeared, or only a few trees are infested, it will usually be cheapest in the end to cut down and burn these trees. The same will hold true of a very badly infested tree, as the difficulty of entirely clearing such a tree would be very great; treatment in such a case requiring a number of applications, while in the time necessary for this, if during the warm months of the year, the scales might spread from this tree to others. The sooner a badly infested tree is destroyed, the better for the orchard and the owner.

LIME.

Lime as a treatment for the scale cannot be used alone with success. Used in combination with other methods of treatment, however, it is of much use. The young scales will not "set" or attach themselves on a tree at points which are covered with lime; hence if the trunk and branches be kept covered with whitewash during the time between the first of June and frost, these portions of the tree will escape. The whitewash may be sprayed on as though it were some spraying solution, particular care being taken to cover every portion with the whitewash, which will stick better if a little salt be added to the solution.

KEROSENE.

The results of treatment with kerosene in the past have been somewhat contradictory. There is no question that where the kerosene actually touches an insect it will kill it, even when quite diluted. Whether it will be able to penetrate the scale and attack the insect beneath, however, in every case, is doubtful. When used pure it will undoubtedly reach and destroy the insect beneath every scale it comes in contact with, and in many cases at least, the tree as well; a result little to be desired. On this point, however, there are differences of opinion. In some cases infested trees have been sprayed with pure kerosene twice during the winter months, and the following summer have been found to be in good condition and with no traces of the scales present. On the other hand, 30,000 peach trees were killed at one time by treatment with kerosene, in Michigan, and similar results are recorded from many other localities.

Under these conditions the advisability of using pure kerosene is very doubtful, particularly if the treatment is to be conducted by persons who have had no experience in its use. In case it is desired to test the kerosene, however, the following suggestions should be followed:

1. Winter treatment should be given in February or March, and the kerosene should not be diluted. Kerosene is more effective on rough barked trees than other sprays because of its penetrating power.
2. Do not waste the kerosene. Use the finest nozzle and stop spraying any portion as soon as it is wet.
3. After the spraying and before the trees start to grow, prune thoroughly.
4. Watch all trees which have been treated, during June, and if crawling young are found, spray the tree with a mixture of five parts of kerosene and one of water.
5. Watch again about the first of September, and treat trees having crawling young as before.
6. After the leaves have fallen search again for the scale and if it is present, spray with a mixture of two parts of water to one of kerosene.
7. If a bad infestation is found before August, spray with pure kerosene in the finest spray possible and using as little as will do the work, choosing a clear dry day with a little breeze blowing. If in August, wait till the fruit is off, then spray with pure kerosene.

These suggestions are practically those made by Dr. Smith, of New Jersey, in his report for 1897. It is my own belief that while treatment with pure kerosene can sometimes, under just the right conditions, be used by experienced persons with success, the danger under

ordinary circumstances, of killing the tree along with the scale is so great, that it should not be made use of unless the grower is prepared to lose all the trees so treated. In any case it should first be tried on a few trees only, as an experiment. Dr. Johnson, of Maryland, gives his opinion on the safety of using kerosene as follows: "After reviewing all the experiments in Maryland, I state most emphatically that pure kerosene sprayed even in the hands of an expert, and in the most careful manner possible, with favorable weather conditions, is a dangerous substance to the vitality and life of young and bearing trees. In all the experiments conducted in this State with pure kerosene on bearing trees, the tree has either been killed or injured, or the fruit buds have been killed."

WHALE-OIL SOAP.

Whale-oil soap was first suggested as a remedy for scale insects in 1880, and has been used for the San José Scale with considerable success. In reality it is a fish-oil, rather than a whale-oil soap. Wherever it has failed to accomplish good results it has usually been due to the soap containing some fats other than the fish oil; hence it is important that the soap should be obtained from a reliable manufacturer.

The soap acts on the scale by the caustic soda or potash it contains, which attacks the scale itself, causing it to corrode and shrivel, lifting it up and thus allowing the oil to work under it and kill the insect beneath.

A good fish-oil soap should be liquid when cold, even when in as strong a mixture as two pounds to a gallon of water. "If it jellies on standing, it contains fats other than fish oil, and imperfect results may be looked for." A soap made with potash is the best for use, as one made with soda becomes semi-solid as it cools, which makes it necessary to apply it hot, while one made with potash will keep quite fluid either hot or cold.

Apparently the most reliable whale-oil soaps now on the market are the "Anchor Brand," made by Leggett & Bro., 301 Pearl St., New York, and "Good's Potash Whale Oil Soap No. 3," made by James Good, of Philadelphia. The former can be obtained in barrel lots (a barrel containing about 450 lbs.) at four cents a pound, or in 100 lb. lots at about six cents a pound. Good's soap can be purchased at from three to three and a half cents a pound, if bought in 275 lb. kegs or 476 lb. barrels. In either case several purchasers by buying together could take large enough quantities to obtain these rates.

Treatment with whale-oil soap should be by adding two pounds of the soap to a gallon of water and applying it to the trees while warm, during the late fall, winter, or early spring. After the leaves are out,

however, treatment with the soap will destroy them and seriously injure the tree. Particular care should be given if peach trees are to be treated, as the fruit buds are sometimes destroyed by it.

If the soap be applied in the fall it appears to affect the set of fruit the following year, and this is of course a drawback to its use. On the other hand, Howard and Marlatt consider fall applications as most likely to be successful in destroying the scale, and that fall treatment increases the general health and vigor of the tree. In the early spring the soaps do not injure the tree, even when it has already begun to grow. If the soap be used in the fall at the rate of one pound to a gallon of water, the injurious effect on the fruit buds appears to be avoided, and good results are obtained.

The best way to use whale-oil soap, therefore, is to spray the trees with one pound of soap to a gallon of water late in the fall, after the leaves have dropped off, and then to spray again just before the buds begin to swell in the spring (usually some time in March), with a mixture of two pounds of the soap to each gallon of water.

As the destruction of the scale is most difficult on the small twigs (it being more difficult to bring the spray in contact with them there than on the larger branches), it is advisable to prune the trees quite carefully immediately after the spring spraying.

The soap has a softening effect on leather, and spraying apparatus with leather valves is not desirable, and metal valves should be used. Several good spray pumps for this purpose are to be obtained, two such being the "Aquapult," made by W. & B. Douglas, of Middletown. Conn., and the "Peerless," made by the Deming Co., of Salem, Ohio.

FUMIGATION.

Fumigation is based on the fact that the scale insects being alive, need air to breathe, and if a poisonous gas replaces the air the insects will be poisoned, while the plants they are on, will not be affected quickly enough to be injured by the treatment.

The poison usually used is Hydrocyanic acid gas which is intensely poisonous to all animals. This treatment has been used for scale insects for some years, but has not been generally adopted in the east, except in Maryland.

To use this treatment gas-tight tents or boxes are used; these being placed over the trees it is desired to fumigate. Under the tent is laid a glazed earthen dish in which the chemicals which produce the gas are placed. The amounts and kinds of chemicals sufficient for one hundred cubic feet of space inside the tent are as follows:

Fresh cyanide of potash, 98 per cent. pure, 25 grams weight.
Commercial sulphuric acid, $1\frac{1}{2}$ oz. measure.
Water, $2\frac{1}{4}$ oz. measure.

Add the acid first, then the water, and finally the cyanide, at once closing the tent tightly. The time of exposure to the gas will vary somewhat, but will be from half and hour to an hour.

The difficulties of treatment by this method are several. The tents or boxes are quite expensive, particularly the larger sizes, one twenty-five feet in diameter costing $18. They are made gas-tight by painting with boiled linseed oil. To handle such a tent a lifting pole with block and pulley, and at least two men are needed. To avoid an entire loss of time, while a tree is being treated, several tents are necessary and such a force could handle a number of tents, one after the other, but the cost of a number of tents is considerable.

Another difficulty in the use of this method is that the larger trees can be treated only with great difficulty. Apparently in Maryland, the trees treated in this way rarely exceeded ten feet in height, to judge from the report on the San José Scale recently issued by that State. The cost of chemicals is slight, but it has been found in many cases, that unless the fumigation is conducted under the supervision of an expert, some of the scales are not destroyed, thus rendering the treatment of less value.

The chief objections to this method then, are: 1. The cost of the tents, several of each of at least three sizes being needed. 2. The amount of assistance necessary to carry out the treatment. 3. The liability of failure to destroy all the scales unless the treatment be supervised by an experienced expert. If to these objections be added the extreme danger of the gas, even if only the smallest quantities are breathed, it becomes very doubtful whether it is advisable to recommend its general use by persons not familiar with the process.

In the case of nursery stock, this method of treatment is excellent, the plants being small, and usually under such conditions that it is possible to thoroughly fumigate them, either in the ground or in a fumigating house. All stock sent out from a nursery should be fumigated in this way before shipment and should be accompanied by a certificate from the shipper that it has been so treated. The deadly nature of the fumes of the gas should not be forgotten, however, and after treatment in a fumigating house, ten minutes at least should pass after the doors are opened, before any one should enter the house.

DISTRIBUTION IN PENNSYLVANIA.

The San José Scale has been located by the Division of Zoology in thirty counties in Pennsylvania, and statements of its presence in twenty-four others have been received. In some cases it has passed from the orchards to the woods and is spreading there. With these facts in mind only one conclusion seems possible: *The San Jose*

Scale is in Pennsylvania to stay. We cannot hope to exterminate it; all that can be done is to hold it in check as far as possible.

SUMMARY OF TREATMENT.

1. Kerosene, while sometimes successful cannot be relied on to destroy the scale unless used so strong as to endanger the trees also. It should be used only after having been tried on a few trees as an experiment first.

2. Fumigation, while effective, is expensive when undertaken by individuals; must be carried on with extreme care; and may prove unsuccessful if undertaken by those not experienced in the work. It can and should be used, however, for the destruction of the scale in nursery stock, proper precautions being taken.

3. The best treatment for the San José Scale which can at present be given for general use is as follows:

a. Keep trunk and limbs covered with whitewash from June 1, till frost appears.

b. Spray infested trees with whale-oil soap, one pound to a gallon of water, after the leaves are off in the fall, and spray again before the buds start in the spring, making the mixture at this time at the rate of two pounds to the gallon of water.

c. Cut back and prune infested trees thoroughly, a few days after spraying.

d. Destroy badly infested stock.

OTHER SCALE INSECTS.

There are a number of scale insects, besides the San José Scale, which are common in Pennsylvania, and which have frequently been received by the Department of Agriculture, having been sent in under the impression that they were samples of the San José Scale. Some of these are here described and figured, in order that any one finding scale insects on his trees or other plants may be aided in determining what the scale is with which he has to deal.

THE OYSTER-SHELL SCALE.

(*Mytilaspis pomorum* Bouché.)

This is probably the most abundant scale insect in the State. It is easily distinguished from the San José Scale by its outline (See Fig. 4), for instead of being circular, with a small hump in the center, it is long and somewhat curved, so that it resembles an oyster shell.

It is quite large, being about an eighth of an inch long, rather

pointed at one end and rounded at the other, and is very noticeable when present. It was probably introduced into this country from Europe during the last century, and is now present in nearly all parts of the United States. It is found on a large number of plants, the more important ones being the apple, pear, plum, quince, raspberry, currant, linden, elm, hawthorn, maple, honeysuckle, ash, willow, poplar, wild cherry, rose and wild grape. In this State it has also been found in great abundance on Clematis virginiana.

The winter is passed in the egg, these being found beneath the

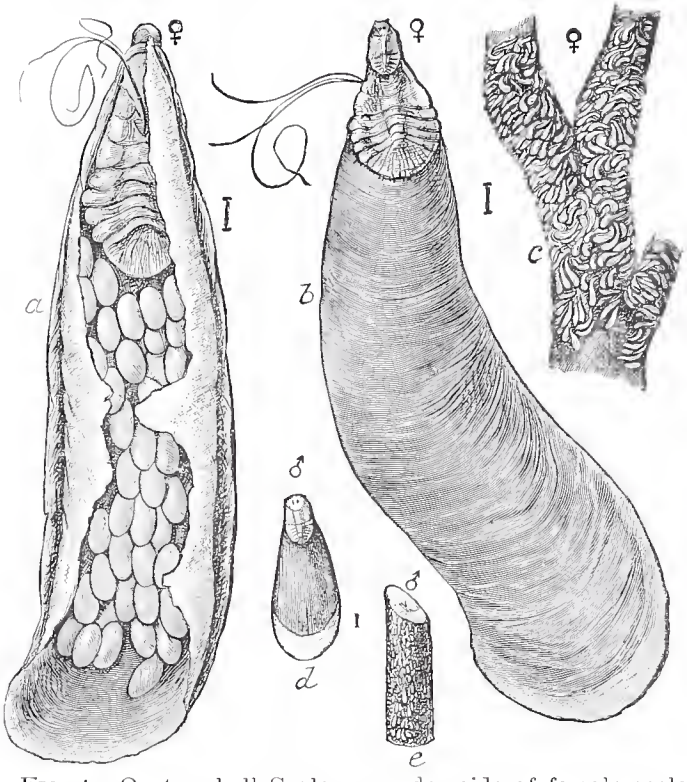

FIG. 4.—Oyster-shell Scale; *a*, under side of female scale showing eggs; *b*, upper side of same, both much enlarged; *c*, female scales on a branch, natural size; *d*, male scale, much enlarged; *e*, male scales on branch, natural size. The fine lines to the right of *a*, *b*, and *d* show the real length of the scales. (*Howard, U. S. Dept. Agr., Yearbook, 1894.*)

female scales at this time, together with the dead body of the parent, there being from forty to ninety yellowish eggs under each scale. These eggs hatch about the last of May or first of June and the young wander about for a short time before settling down. Each young insect inserts its beak into the wood and begins to secrete the scale which is mainly produced from the hinder portion of the body. The females produce a much larger scale than do the males. There is probably but one brood a year in the North, and two in the South.

THE SCURFY SCALE.

(*Chionaspis furfurus* Fitch.)

The Scurfy Scale is quite abundant in Pennsylvania. It is a native of North America, but seems to be less abundant in the Northern than in the Middle States, apparently preferring a warmer climate.

It has been found on the apple, crab apple, pear, quince, black cherry, choke cherry, currant, peach, Japan quince and mountain ash.

It is an irregularly shaped scale somewhat pointed at one end, and quite broad, rounded and whitish in color. It is about as long as

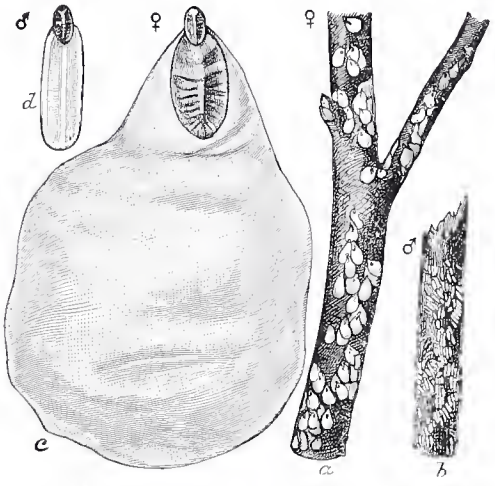

FIG. 5.—Scurfy Scale: *a*, female, *b*, male scales, natural size, on twigs; *c*, female scales, much enlarged; *d*, male scale, much enlarged. (*Howard, U. S. Dept. Agr., Yearbook, 1894.*)

the Oyster Shell Scale but much broader (see Fig. 5), and may be easily separated from it by its lighter color.

This insect also passes the winter in the egg, beneath the scale of the parent, from ten to seventy-five being present under each scale. The eggs hatch in May, and the remainder of the life history is about the same as that of the Oyster-Shell Scale. The male scales are quite different from those of the females, being much smaller, and of nearly the same width everywhere, as is shown in Fig. 5, d. They are also very white in color, except at the pointed end. There is probably but one brood a year in Pennsylvania.

THE PEACH DIASPIS.

(*Diaspis lanatus* Morg. & Cock.)

This scale is included here (see Fig. 6), not because of its presence in Pennsylvania, as it has thus far been reported from only three places in the United States, but because one of these places (the District of Columbia) is so near this State that it may appear along our southern border at any time. It is probably a native of the West Indies, and

besides the District of Columbia, has thus far been found only in Florida and Georgia. In the first named locality it has been found

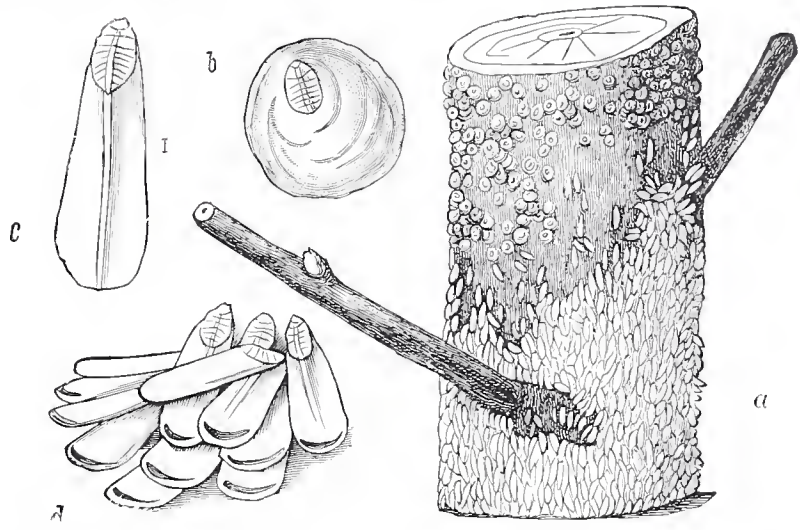

FIG. 6.—Peach Diaspis; *a*, branch with male and female scales, natural size; *b*, female scale, *c*, male scale, *d*, group of male scales, all much enlarged. (*Howard, U. S. Dept. Agr., Yearbook, 1894.*)

only on the peach; in the other two it occurs on the plum also. Figure 6 gives a good idea of its appearance, and peach growers should be on the watch for it.

THE ENGLISH WALNUT SCALE.

(*Aspidiotus juglans-regiæ* Comst.)

This scale much resembles the San José Scale in general appearance, the female scale being circular in outline, with a hump a little to one

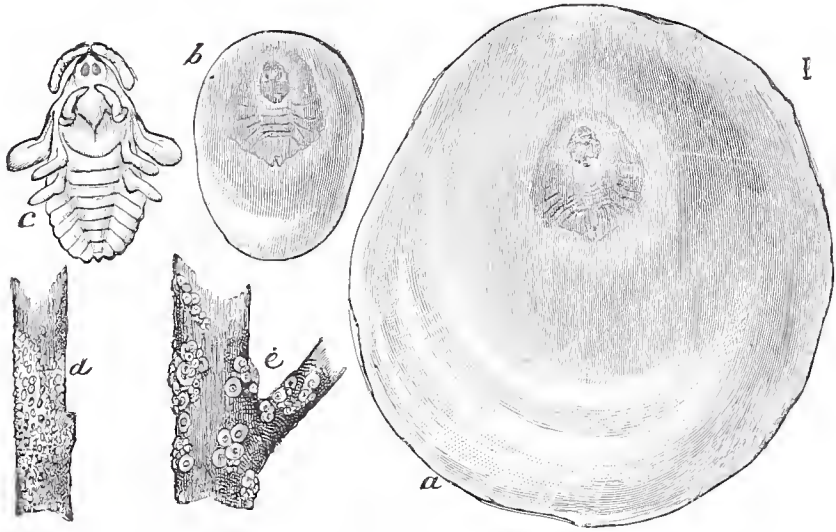

FIG. 7.—English Walnut Scale; *a*, female scale, *b*, male scale, both much enlarged; *d*, male scales, *e*, female scales, both natural size, on twigs. (*Howard, U. S. Dept. Agr., Yearbook, 1894.*)

side of the center (Fig. 7). It has been found in California, New York, District of Columbia, Louisiana, New Mexico, Texas, Florida and

Mississippi, and occurs on the English walnut, pear, apple, peach, cherry, plum, apricot, ash and locust. It has not been reported as yet from Pennsylvania, but as it is present both north and south of this State it is likely to be found here at any time. It is a little larger than the San José Scale. There are several broods each year.

PUTNAM'S SCALE.

(*Aspidiotus ancylus* Put.)

Putnam's Scale is also liable to be mistaken for the San José Scale which it much resembles. It has not as yet been reported from Pennsylvania, but as it occurs in New York and Ohio it may be discovered here at any moment. The characters by which it may be distinguished from the San José Scale are so slight that critical examination is often necessary to separate the two. It has been found on the apple, pear, peach, plum, currant, maple, ash, beech, linden, oak and other plants.

THE ROSE SCALE.

(*Diaspis rosæ* Sandb.)

This insect somewhat resembles the Scurfy Scale already described, but the female is more nearly circular in outline (Fig. 8). It is pure white or slightly greyish in color, with a darker spot as shown in the

FIG. 8.—Rose Scale; *1*, female scales on rose, natural size; *1a*, female scale, much enlarged; *1b*, male scale, much enlarged. (*Comstock, U. S. Dept. Agr. Rept. 1880.*)

figure, near one edge. It is not uncommon in Pennsylvania on the

rose, raspberry and blackberry, but is not usually so abundant as to be seriously injurious to either of these plants.

THE PEACH LECANIUM.

(*Lecanium persicæ* Modeer.)

This scale is entirely different in appearance from any of those described above, being of the shape and size shown in Figure 9 on the twig. In this form they pass the winter. The eggs hatch during a period of about a month, beginning about June 10th. By the first of August the female scales are about half grown, but nearly all have reached full size before winter. There seems to be but one brood a year.

These insects are often referred to as the unarmored scales. Others, similar in appearance, but smaller, are found on the plum, quince and apple. Another, nearly as large as the Peach Lecanium occurs on the tulip tree. Ashes, maples and other forest trees are also attacked by different kinds of Lecaniums and quite recently one of this group was found in abundance on the clematis (*Clematis paniculata*).

TREATMENT FOR SCALE INSECTS.

Treatment for scale insects varies according to the particular scale

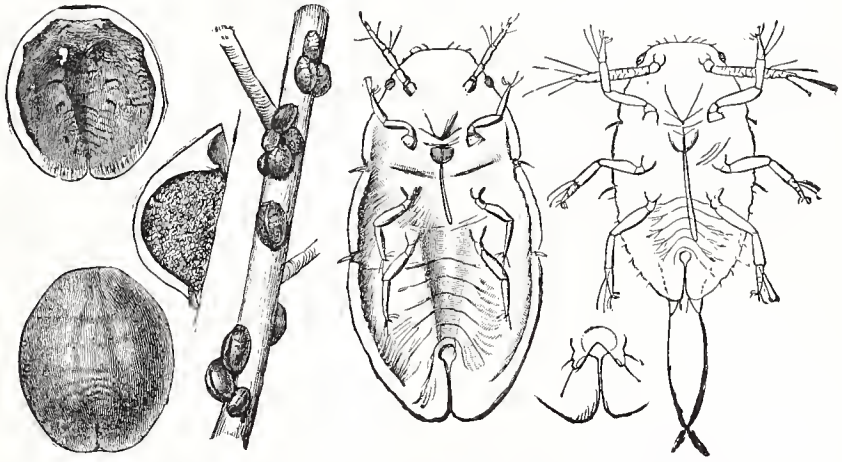

FIG. 9.—Peach Lecanium; female scales on twig, natural size; upper side of scale in upper left hand corner; under side of same, in lower left hand corner; scale cut lengthways, in middle on left side of figure; young and fullgrown, but still crawling scale, at right side of figure; all much enlarged except the scales on the twig. (*Howard, U. S. Dept. Agr., Yearbook, 1894.*)

to be dealt with. Undoubtedly the most difficult one to destroy is the San José Scale, methods for the treatment of which have already been given at length. These same methods will destroy any of the other scale insects here considered, but in most cases less severe

measures will be sufficient. For the Oyster Shell Scale, the Scurfy Scale, the Rose Scale and the Lecaniums, spraying twice with one part kerosene emulsion added to nine parts of water, once about the fifth of June and again about the last of that month should be effective. For the Peach Diaspis, the Walnut Scale and Putnam's Scale the treatment recommended for the San José Scale will probably prove most effectual. For the Plum Lecanium it has been found that spraying with one part of kerosene emulsion added to four parts of water, applied once before winter sets in; once during the winter, and once in March, is the best treatment, this species differing from the peach Lecanium in the stage in which it passes the winter.

HOW TO SPRAY FOR SCALE INSECTS.

In spraying for scale insects it should be borne in mind that the object to accomplish is to hit each scale with the spray. As the scales lie above, below and on the sides of the twigs and branches, to accomplish this purpose the spray should be thrown upward from beneath; thrown above the tree to fall on the upper sides of the twigs, and aimed at both sides of the branches as well. To do thorough work, after spraying from above and from below, it is well to move around the tree twice, once each way, spraying at the sides of the branches rather than in towards the trunk. Do not spray till the tree begins to drip, but just enough to reach every portion so far as possible.

In case of doubt as to what scale is present, or the best treatment to use in any particular case, inquiries should be made of the Division of Zoology, Department of Agriculture, Harrisburg, Pa., sending samples of the infested plants for examination.

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